

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16272J

THREE-PHASE PAD-MOUNTED TRANSFORMERS

02/05

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS
- 1.4 QUALIFICATION TESTING

PART 2 PRODUCTS

- 2.1 PAD-MOUNTED LIQUID-FILLED DISTRIBUTION TRANSFORMERS
  - 2.1.1 Compartments
    - 2.1.1.1 High Voltage, Dead-Front
    - 2.1.1.2 Low Voltage
  - 2.1.2 Transformer
  - 2.1.3 Insulating Liquid
    - 2.1.3.1 Less-Flammable Transformer Liquids
  - 2.1.4 Corrosion Protection
- 2.2 Final Acceptance, Test Reports and Certificates

PART 3 EXECUTION

-- End of Section Table of Contents --

SECTION 16272J

THREE-PHASE PAD-MOUNTED TRANSFORMERS  
02/05

\*\*\*\*\*

NOTE: This guide specification covers three-phase pad-mounted transformers of the dead-front and live-front types for exterior applications.

Use pad-mounted transformers (properly protected with bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses) for kVA ratings up to and including 750 kVA on 5 kV systems and for kVA ratings up to and including 1500 kVA on 15 and 25 kV systems.

For voltages above 25 kV and in ratings above those previously indicated, this specification requires significant modifications and additional specification sections may need to be added on the project.

The use of pad-mounted transformers with secondary currents exceeding 2000 amperes is discouraged due to the size and quantity of secondary conductors. Therefore, transformers above 750 kVA serving 208Y/120 volt loads and transformers above 1500 kVA serving 480Y/277 volt loads should be in a secondary unit substation configuration.

Contact the cognizant EFD or PWC for direction.

For SOUTHNAVFACENGCOM projects, use of secondary unit substations shall be determined on a case by case basis.

Use the following related guide specifications for power distribution equipment:

- Section 16081, "Apparatus Inspection and Testing"
- Section 16273, "Single-Phase Pad-Mounted Transformers"
- Section 16301, "Overhead Transmission and Distribution"
- Section 16341, "Pad-Mounted SF6 Insulated Interrupter Switches"
- Section 16360, "Secondary Unit Substations"
- Section 16361, "Primary Unit Substations"

Comments and suggestion on this specification are welcome and should be directed to the technical proponent of the specification. A listing of the technical proponents, including their organization designation and telephone number, is on the Internet.

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

\*\*\*\*\*

\*\*\*\*\*

NOTE: This section utilizes the following energy cost and loss value tables. These tables are located on the CCB in the file, Libraries/ Specifications/NAVFAC Guide Specifications/ Basic Specifications/NAVFAC Guide Specification Graphics (Inch-Pound), under bookmark 16272 THREE-PHASE PAD-MOUNTED TRANSFORMERS.

Do not include list of tables, or tables themselves, in project specifications. Use tables to obtain values required in Part 2 of the specification.

<u>TABLE NUMBER</u>	<u>TITLE</u>
PM-1	Transformer Loss & Impedance Data - for Energy Cost (EC) Less Than or Equal to \$0.04 (2 pages)
PM-2	Transformer Loss & Impedance Data - for Energy Cost (EC) Greater Than \$0.04 and Less Than or Equal to \$0.08 (2 pages)
PM-3	Transformer Loss & Impedance Data - for Energy Cost (EC) Greater Than \$0.08 and Less Than or Equal to \$0.12 (2 pages)
EC-1	Energy costs at LANTNAVFACENGCOM Activities (2 pages)
EC-2	Energy costs at SOUTHNAVFACENGCOM Activities (2 pages)

-----

\*\*\*\*\*

\*\*\*\*\*

NOTE: The following information shall be shown on the project drawings:

1. Single-line diagram showing pad-mounted transformer connectors, inserts, surge arresters, switches, fuses, current transformers with ratings, and meters as applicable.
2. Grounding plan.
3. Type and number of cables, and size of conductors for each power circuit.
4. Transformer primary and secondary voltages.

(Use IEEE C57.12.00, Table 11(b), "Designation of voltage ratings of three-phase windings".) State the primary voltage (nominal) actually in service and not the voltage class.

5. Special conditions, such as altitude, temperature and humidity; exposure to fumes, vapors, dust, and gases; and seismic requirements.

\*\*\*\*\*

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

#### AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- |                |  |
|----------------|--|
| ANSI C37.47    | (2000) For High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches   |
| ANSI C57.12.22 | (1993) Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA and Smaller: High Voltage, 34 500 Grd Y /19 920 Volts and Below; Low Voltage, 480 Volts and Below |
| ANSI C57.12.26 | (1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVA and Smaller                      |
| ANSI C57.12.28 | (1999) Pad-Mounted Equipment - Enclosure Integrity   |

#### ASTM INTERNATIONAL (ASTM)

- |            |   |
|------------|---|
| ASTM A167  | (1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip                                 |
| ASTM D1535 | (1997) Specifying Color by the Munsell System   |
| ASTM D877  | (1987; R 1995) Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes                           |
| ASTM D92   | (1998; Rev. A) Flash and Fire Points by Cleveland Open Cup IP Designation: 36/84 (89); AASHTO No.: T48; DIN51 376 |

FACTORY MUTUAL RESEARCH CORPORATION (FMRC)

FM P7825

(2003) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386

(1995;R 2001) Standard for Separable  
Insulated Connector Systems for Power  
Distribution Systems Above 600V

IEEE C57.12.00

(2000) Standard General Requirements for  
Liquid-Immersed Distribution, Power, and  
Regulating Transformers (ANSI/IEEE)

IEEE C57.12.80

(2002) Standard Terminology for Power and  
Distribution Transformers

IEEE C57.12.90

(1999) Standard Test Code for  
Liquid-Immersed Distribution, Power, and  
Regulating Transformers (ANSI/IEEE)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2002) National Electrical Code

1.2 GENERAL REQUIREMENTS

\*\*\*\*\*  
NOTE: Include NAVFACENGCOM Section 16081,  
"Apparatus Inspection and Testing" on all projects  
involving medium voltage and specialized power  
distribution equipment.  
\*\*\*\*\*

Provide a pad-mounted stainless steel distribution transformer as listed  
below and as specified in this section.

- a. 1000 kVA, 13.2kV (delta) - 480/277 (wye).
- b. 300 kVA, 13.2kV (delta) - 208/120 (wye).

1.3 SUBMITTALS

\*\*\*\*\*  
NOTE: Where a "G" in submittal tags follows a  
submittal item, it indicates Government approval for  
that item. Add "G" in submittal tags following any  
added or existing submittal items deemed  
sufficiently critical, complex, or aesthetically  
significant to merit approval by the Government.  
Submittal items not designated with a "G" will be  
approved by the QC organization.  
\*\*\*\*\*

\*\*\*\*\*  
NOTE: Include the bracketed option on "CI44 and 074  
review" for LANTNAVFACENGCOM and SOUTHNAVFACENGCOM  
projects respectively. For other projects,  
submittal review shall be performed by the designer  
of record. If submittal review by LANTNAVFACENGCOM

or SOUTHNAVFACENGCOM is specifically desired, the responsible Government agency must coordinate with the respective Code CI44 or 074 during the design process. Add appropriate information in section entitled "Submittal Procedures" to coordinate with the special requirements.

\*\*\*\*\*

The following shall be submitted in sufficient detail to show full compliance with the specification:

#### SD-03 Product Data

Equipment and Performance Data shall be submitted for Distribution Transformers including resistance measurements, impedance, and voltage and load losses at rated currents.

Equipment Foundation Data for Distribution Transformers shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

Manufacturer's Catalog Data shall be submitted for the Distribution Transformers.

#### SD-06 Test Reports

Acceptance Test Reports shall be submitted for the following:

Insulation Liquid Dielectric Tests  
Insulation resistance Tests  
Power Factor Tests  
Transformer Turns Ratio Tests  
High Potential Tests

#### SD-07 Certificates

Certificates of Compliance of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature-rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

Certificates of Compliance for equipment coatings meeting requirements of ANSI C57.12.28.

### 1.4 QUALIFICATION TESTING

Tests on transformers shall comprise the manufacturer's standard tests including resistance measurements of all windings; ratio tests; polarity and phase-relation tests; no-load loss at rated voltage; impedance; voltage and load loss at rated current; insulation power factor (Doable) tests, insulation oil tests, and dielectric tests. For oil-filled units manufacturer shall certify that the oil contains no PCB's and shall affix a label to that effect on the transformer tank. Submit the following to Engineer for review:

#### Product Data

Equipment and Performance Data  
Equipment Foundation Data  
Manufacturer's Catalog Data

## PART 2 PRODUCTS

### 2.1 PAD-MOUNTED LIQUID-FILLED DISTRIBUTION TRANSFORMERS

\*\*\*\*\*  
**NOTE: For LANTNAVFACENGCOM projects, change Section 16302, "Underground Transmission and Distribution" to Section 16303 "Underground Electrical Work", (typical throughout this specification).**  
\*\*\*\*\*

Pad-mounted liquid-filled distribution transformers with primary connections to underground high-voltage; voltage lines and secondary connections to underground low-voltage distribution feeder circuits shall be two-winding, three-phase, 60-hertz, oil-immersed, 65-degree C rise, self-cooled, Class OA, outdoor type, conforming to ANSI C57.12.22, ANSI C57.12.26, IEEE C57.12.00, IEEE C57.12.80, and IEEE C57.12.90. Primary windings of three-phase pad-mounted transformers shall be delta/wye connected.

Windings shall be aluminium or copper.

#### 2.1.1 Compartments

The high and low-voltage compartments shall be located side by side separated by a steel barrier. When facing the transformer, the low voltage compartments shall be on the right. Terminal compartments shall be full height, air filled, with individual doors. The high voltage door fastenings shall not be accessible unless the low voltage door has been opened. The low voltage door shall have a 3-point latching mechanism with vault like handle having provisions for a single padlock. The doors shall be equipped with lift-off, stainless steel hinges to allow the doors to be removed and door stops to hold the doors open if not removed while working in the compartments.

Transformer stand components as shall be listed and in accordance with ANSI C57.12.26.

\*\*\*\*\*  
**NOTE: Current policy is to use oil-immersed fuses in series with current limiting fuses to achieve better protection and obtain life cycle cost benefits. Use dry-well canister fuses only when specifically required by the activity.**

**Do not provide standoff bushings unless this transformer is the only dead-front transformer on the base. Public works normally carries standoff bushings in their vehicles. Provide protective caps when providing standoff bushings and to cover unused bushing well inserts when not providing surge arresters.**

\*\*\*\*\*

### 2.1.1.1 High Voltage, Dead-Front

High-voltage compartment shall contain the incoming line, six high-voltage bushing wells configured for loop feed application, access to oil-immersed fuses, tap changer and load break switch handle, connector parking stands with protective caps and ground pad.

\*\*\*\*\*  
**NOTE: The following paragraph is based on**  
**200-ampere connectors. If transformer primary load**  
**current is greater than 200 amperes or if primary**  
**cable size is greater than No. 4/0 AWG, designer**  
**shall determine the appropriate connector system.**  
 \*\*\*\*\*

Loop Feed Sectionalize Switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch shall be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches shall be as follows:

ARRANGE- MENT NO.	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION					
		LINE A SW.		LINE B SW		XFMR. SW	
		OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE
1	Line A connected to Line B and both lines connected to transformer		X		X		X
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line B only	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. Bayonet fuse links shall sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing which



closes when the fuse holder is removed and an external drip shield. Warning shall be conspicuously displayed within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the open position and the tank pressure has been released.

Fuse Assembly: 150 kV BIL

Oil-Immersed Current-Limiting Fuses: ANSI C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

Protective Caps: IEEE 386, 200 amperes, 15 kV Class. provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushing well inserts.

#### 2.1.1.2 Low Voltage

\*\*\*\*\*  
**NOTE: Installation of circuit breakers in the secondary compartment is not recognized by ANSI standards, and limits accessibility by covering lugs, gages, and accessories. Do not use.**  
\*\*\*\*\*

Low-voltage compartment shall contain low-voltage bushings with NEMA spade terminals, accessories, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

Accessories shall include drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

The low-voltage bushings shall be molded epoxy, and provided with 8-hole blade-type space terminals with NEMA standard hole spacing arranged for vertical take-off. The low-voltage neutral shall be an insulated bushing, grounded to the tank by a removable bonding jumper.

#### 2.1.2 Transformer

\*\*\*\*\*  
**NOTE: Use the following guidelines for specifying transformers.**

1. Use mineral oil filled transformers wherever possible. Where adequate distance from structures cannot be attained, consult NAVFAC design manuals and MIL-HDBK-1008, "Fire Protection for Facilities Engineering, Design, and Construction." Caution should be used in specifying less-flammable liquid filled transformers. A thorough analysis should be made by the designer prior to using silicone filled transformers due to the concern over operation of switches, tap changers, and bayonet oil-immersed expulsion fuses within the silicone liquid.

2. Use IEEE C57.12.00, Figure 3(b), voltage designations, such as "4160 V - 480Y / 277 V".

3. Select impedance value in accordance with

technical note under paragraph entitled "Specified Transformer Losses."

4. Delete inapplicable sound levels.

5. Delete last sentence if transformer secondary winding is delta type.

\*\*\*\*\*

Transformers shall be rated 1000 kVA, 95 kV BIL. Primary voltage 13.2 kV delta, secondary voltage 480/277V wye, 4-wire, 60 Hz.

Transformers shall be rated 300 kVA, 95 kV BIL, primary voltage 13.2 kV delta. Secondary voltage 208/120V wye, 4-wire, 60 Hz.

Transformer shall be stainless steel, (Tank, Base sill, and enclosure) Type 304 or 304L, sealed-tank construction of sufficient strength to withstand a pressure of 7 psi without permanent distortion. The cover shall be welded and the fastenings tamperproof. The transformer shall remain effectively sealed for a top oil temperature range of -30 C to 105 C. When required, cooling panels will be provided on the back and the sides of the tank. Lifting eyes and packaging pads will be provided. Enclosure shall conform to ANSI C57.12.28. Submit Certificates of Compliance for equipment coatings. Finish paint shall be Munsell Green.

Tap changer shall be externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Tap changers shall clearly indicate which tap setting is in use.

Impedance shall be ANSI standard impedance for size and type.

Audible sound levels shall comply with the following:

<u>kVA</u>	<u>DECIBELS (MAX)</u>
75	51
112.5	55
150	55
225	55
300	55
500	56
750	57
1000	58
1500	60

Transformer shall include lifting lugs and provisions for jacking under base. The transformer base construction shall be suitable for using rollers or skidding in any direction.

#### 2.1.3 Insulating Liquid

##### 2.1.3.1 Less-Flammable Transformer Liquids

NFPA 70 and FM P7825 for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877. Do not provide nonflammable transformer liquids including askarel and insulating liquids containing polychlorinated biphenyls (PCB's) and tetrachloroethylene

(perchloroethylene), chlorine compounds, and halogenated compounds.  
Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

#### 2.1.4 Corrosion Protection

\*\*\*\*\*  
**NOTE: Use stainless steel bases and cabinets for most applications. In hostile environments, the additional cost of totally stainless steel tanks and metering may be justified. Manufacturer's standard construction material is acceptable only in noncoastal and noncorrosive environments.**  
\*\*\*\*\*

Bases and cabinets of transformers shall be corrosion resistant and shall be fabricated of stainless steel conforming to ASTM A167, Type 304 or 304L. Base shall include any part of pad-mounted transformer that is within 75 mm 3 inches of concrete pad. Paint bases, cabinets, and tanks Munsell 7GY3.29/1.5 green. Paint coating system shall comply with ANSI C57.12.28 regardless of base, cabinet, and tank material. The Munsell color notation is specified in ASTM D1535.

#### 2.2 Final Acceptance, Test Reports and Certificates

Prior to final acceptance, Subcontractor must submit the following to the Engineer of Record for final review and approval:

##### Test Reports

Acceptance Test Reports shall be submitted for the following:

Insulation Liquid Dielectric Tests  
Insulation resistance Tests  
Power Factor Tests  
Transformer Turns Ratio Tests  
High Potential Tests

##### Certificates

Certificates of Compliance of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature-rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

#### PART 3 EXECUTION

Not Used

-- End of Section --